The Evolution of U.S. Wages: Skill Prices versus Human Capital

Lutz Hendricks

UNC

Preliminary and incomplete
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3 facts about post-war U.S.:

1. Educational attainment has increased.
2. Unskilled wages have declined (since the mid 1960s).
3. The college wage premium has roughly doubled (since 1980).
1. Do the wage movements reflect changes in
   - skill prices or
   - labor quality (human capital)?

2. How can skill prices be inferred from measured wages?

The problem: wages confound skill prices and human capital.
Why Is This Interesting?

1. Rising education may mean: less able students enter higher education levels. Does this account for falling unskilled wages?
2. The correlation between schooling and ability has increased over time. Does this account for the rising college premium?
3. Implications for returns to schooling, contribution of human capital to growth, ...
The Idea

View the age wage profiles of various cohorts through the lens of human capital theory.

Theory implies:

1. Concave age efficiency profiles.
2. When skill prices grow, wages of all cohorts move together.
3. As schooling expands, the relative abilities of college / high school educated workers change.
The Approach

- Develop a model of school choice and on-the-job training.
- Calibrate the model to fit the age wage profiles of synthetic cohorts.
- The model measures:
  - unobserved skill prices and labor qualities
  - the abilities of workers by [schooling, cohort]
One-third of the growth in the college wage premium is growth in the relative human capital of college educated workers.

Half of the college wage premium in 2000 reflects the relative human capital of college graduates.

Unskilled wages did not fall nearly as much as the data suggest.
A Roy/Ben-Porath Model
Overlapping generations.

Endowments at birth:
- ability (learning productivity) $a$,
- human capital $h_1$,
- school preferences $p$.

Choose from 4 school levels:
- high school dropout (HSD) and graduate (HSG)
- college dropout (CD) and graduate (CG)

Attend school for $T_s$ periods and produce human capital.

Work until age $T$ with on-the-job training.
- Maximize lifetime earnings.
State variables: human capital $h$, age $t$, $z = (a, s, \tau)$: ability, schooling, cohort.

$$V(h_t, t, z) = \max_{l_t} y(l_t, h_t, t, z) + R^{-1} V(h_{t+1}, t+1, z)$$

subject to law of motion for $h$:

$$h_{t+1} = (1 - \delta) h_t + e^{\theta a} A(s) e^{\gamma a t} (h_t l_t)^{\alpha}$$

ability productivity inputs

definition of period earnings

$$y(l_t, h_t, t, z) = w_{s, t+\tau-1} h_t (\ell_{t,z} - l_t)$$

time constraint $0 \leq l_t \leq \bar{l}\ell_{t,z}$. 
Schooling Phase

School choice:

\[ W(h_1, a, p, \tau) = \max_s W_s(h_1, a, p, \tau) \]

\[ W_s(h_1, a, p, \tau) = \ln \left( R^{-T_s+1} V(h_{T_s+1}, T_s + 1, a, s, \tau) \right) \]

\[ + \pi_{\tau \rho T_s} + \mu_{s, \tau} \]

\( h_{T_s+1} \): produced using the job-training technology with \( I_t = \ell_{t,s,\tau} \).

\( \pi_{\tau \rho T_s} \): a stand-in friction to ability sorting (psychic cost).

\( \mu_{s, \tau} \): chosen so that the model matches observed schooling for each cohort.
For now: partial equilibrium.

Skill prices $w_{s,v}$ are exogenous.

GE is a task for future work.
Calibration
Choose parameters to match:

1. **Age wage profiles**
   mean log wages for 5 synthetic cohorts (CPS data)

2. **IQ scores of college / high school students (Taubman/Wales).**
   In the model: IQ is a noisy measure of $a$ and $h_1$.

3. $\beta_{IQ}$: coefficient from regressing log wage (age 40) on IQ
   (and school dummies)
Age Wage Profiles

Slopes of age wage profiles

Intercepts of age wage profiles

Change in mean log wage, ages 25 to 40

Mean log wage at age 25
### Fixed parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$</td>
<td>Lifespan</td>
<td>50</td>
</tr>
<tr>
<td>Birth cohorts</td>
<td>Cohort 1 1930 - 1936</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohort 2 1937 - 1943</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohort 3 1944 - 1950</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohort 4 1951 - 1957</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cohort 5 1958 - 1964</td>
<td></td>
</tr>
<tr>
<td>$T_s$</td>
<td>School duration</td>
<td>(1, 3, 5, 7)</td>
</tr>
<tr>
<td>$\ell_{t,s,\tau}$</td>
<td>Market hours CPS data</td>
<td></td>
</tr>
<tr>
<td>$R$</td>
<td>Gross interest rate</td>
<td>1.04</td>
</tr>
</tbody>
</table>
Calibrated Parameters

- Job training / schooling technology.
- Preferences shocks.
- IQ distribution given \((a, h_1)\).
- Endowments: \((a, \ln h_1, p) \sim N\)
- Skill prices: \(w_{s,v}\)
  - calibrate at 5 dates; cubic spline in between.
Calibrated Parameters

Highlights:

1. Human capital production function is strongly concave: $\alpha = 0.24$
   - estimates in the literature: 0.5 to 1
   - important for effect of training on lifetime earnings

2. Human capital endowments decline over time: $g_{h1} = -0.011$
   - b/c mean log wages are falling over time in the data
## Calibrated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-the-job training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A(s)$</td>
<td>Productivity</td>
<td>0.690 0.769 0.953 0.925</td>
</tr>
<tr>
<td>$g(A(s))$</td>
<td>Productivity growth rate</td>
<td>0.0007</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Curvature</td>
<td>0.237</td>
</tr>
<tr>
<td>$\delta_h$</td>
<td>Depreciation rate</td>
<td>0.044</td>
</tr>
<tr>
<td><strong>Endowments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_{h_1}$</td>
<td>Dispersion of $h_1$</td>
<td>0.011</td>
</tr>
<tr>
<td>$g(h_1)$</td>
<td>Growth rate of $h_1$</td>
<td>-0.0110</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Ability scale factor</td>
<td>0.150</td>
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<tr>
<td>$\pi$</td>
<td>Psychic cost scale factor</td>
<td>0.182</td>
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<tr>
<td>$g(\pi)$</td>
<td>Growth rate of $\pi$</td>
<td>-0.0387</td>
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<tr>
<td>$\gamma_{pa}$</td>
<td>Governs correlation of $\pi$ and $a$</td>
<td>0.500</td>
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<tr>
<td>$\gamma_{ha}$</td>
<td>Governs correlation of $\ln h_1$ and $a$</td>
<td>0.747</td>
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<tr>
<td>$\gamma_{hp}$</td>
<td>Governs correlation of $\ln h_1$ and $\pi$</td>
<td>0.302</td>
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<tr>
<td>$\sigma_{IQ}$</td>
<td>Noise in IQ</td>
<td>0.854</td>
</tr>
<tr>
<td>$\gamma_{IQ,a}$</td>
<td>Governs correlation of $a$ and $IQ$</td>
<td>0.776</td>
</tr>
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</table>
Model Fit

Results
Revisions to Wage Growth

The question:

*How much do the growth rates of wages differ from the growth rates of skill prices?*

The experiment:

Compare the paths of data wages $z_{s,v}$ with model skill prices $w_{s,v}$. 
Revisions to Wage Growth

Unskilled model wages grow much faster than data wages.
Changing Student Abilities

Mean effective ability over birth year.

- HSD
- HS
- CD
- CG
One-third of the rise in the college wage premium is due to human capital, not skill prices.
### Revisions to Wage Growth

<table>
<thead>
<tr>
<th>School group</th>
<th>Skill price growth</th>
<th>Skill premium growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>HSD</td>
<td>-32.7</td>
<td>-1.3</td>
</tr>
<tr>
<td>HS</td>
<td>-20.6</td>
<td>-10.3</td>
</tr>
<tr>
<td>CD</td>
<td>-9.0</td>
<td>-15.8</td>
</tr>
<tr>
<td>CG</td>
<td>20.2</td>
<td>17.0</td>
</tr>
</tbody>
</table>

**Result:**

One-third of the rise in the college wage premium is due to human capital, not skill prices.
Revisions to Wage Growth

![Graphs showing mean log wage over years for different models and data sets.](Image)

- **Model** vs. **Data**
- Mean log wage range: 0.6 to 1.3
College Premium

Log wage relative to HSG

- Model
- Data

Year

The question:

*How much do selection / investment contribute to skill premiums at a point in time?*

Experiment: solve the model for 3 scenarios:

1. **Baseline**

2. **No selection:** workers in all school groups have mean endowments $a = 0$ and $\ln h_1 = g_{h1} \tau$

3. **Common investment:** workers in all school groups share $l_{t,s}$ set to median age profile of high school graduates

Compute mean log wages at age 40 for each cohort / school group.
Selection accounts for half of the year 2000 college wage premium.
Selection and Lifetime Earnings

The question:

*How much of the lifetime earnings gap CG / HSG is due to selection?*

The experiment:

- Solve the model with random school assignment.
- Compare lifetime earnings by \((s, \tau)\) with baseline.
Result: 15 log points of the college lifetime earnings premium are due to selection
Kuruscu (2006): Job-training has almost no effect on lifetime earnings
- typical estimates of the curvature of the human capital production function: $\alpha \in [0.5, 1]$.
- human capital depreciation must then be small: $\delta \approx 1\%$

This model: $\alpha = 0.24$, $\delta = 4.4\%$.
- different because I fit cohort age-wage profiles (as opposed to cross sections)

Training then increases lifetime earnings between 50% and 80%.
A simple human capital model accounts well for the age wage profiles of cohorts observed since 1930.

Labor quality accounts for

- **half** of the college wage premium (1960 cohort)
- **1/3** of the rise in the college wage premium
- **1/4** of the lifetime college earnings premium (1960 cohort)